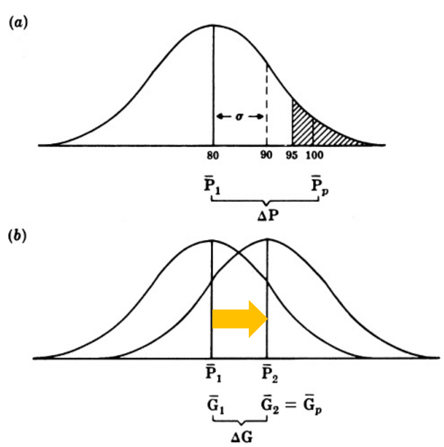
Jalostushyödyt tutkimustiedon valossa

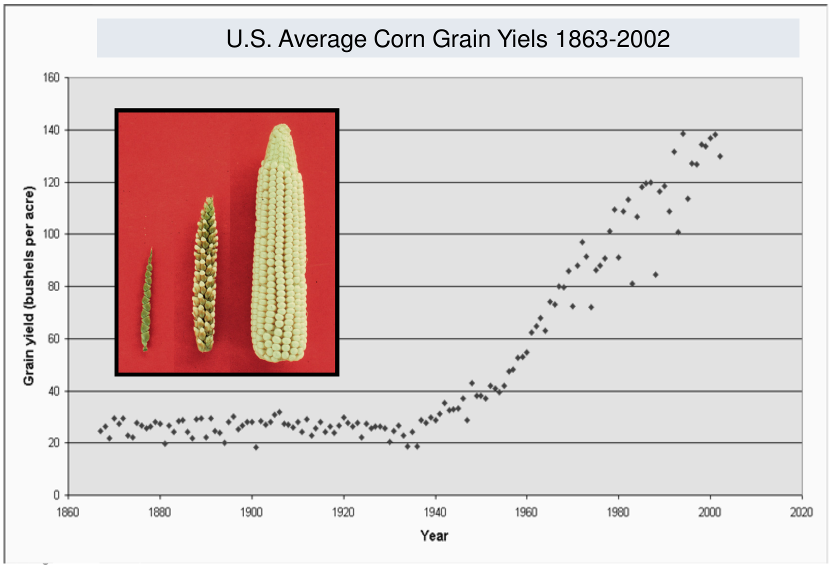
Matti Haapanen

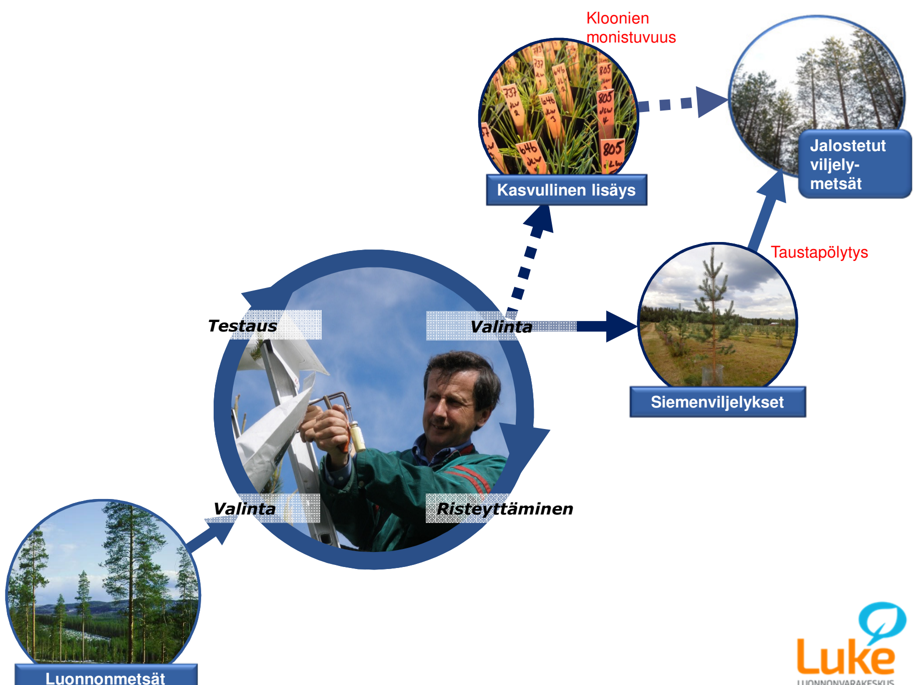
Jalostushyöty

- Valinnasta johtuva ominaisuuden keskiarvon muutos
- Jos ominaisuus on periytyvä, muutos on väistämätön



Maissin jalostushyöty





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Metsäpuiden jalostushyödyistä

- Jalostusprosessista ei saa ”sivutuotteena” ajantasaista ja tarkkaa tietoa realisoituvista jalostushyödyistä
- Siemeneriä on vertailtava **järjestetyissä kenttäkokeissa**
- Tiedon saaminen vie paljon aikaa
- Kokeiden ja tutkimustiedon määrä vaihtelee eri puulajeilla
- Pituuskasvu useimmin mitattu tunnus
- Varttuneemmissa kokeissa mitattu myös rungon läpimittaa sekä erilaisia oksikkuuslaatua kuvaavia tunnuksia

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Männyn jalosteiden vertailukoe 636/1 Somerolla

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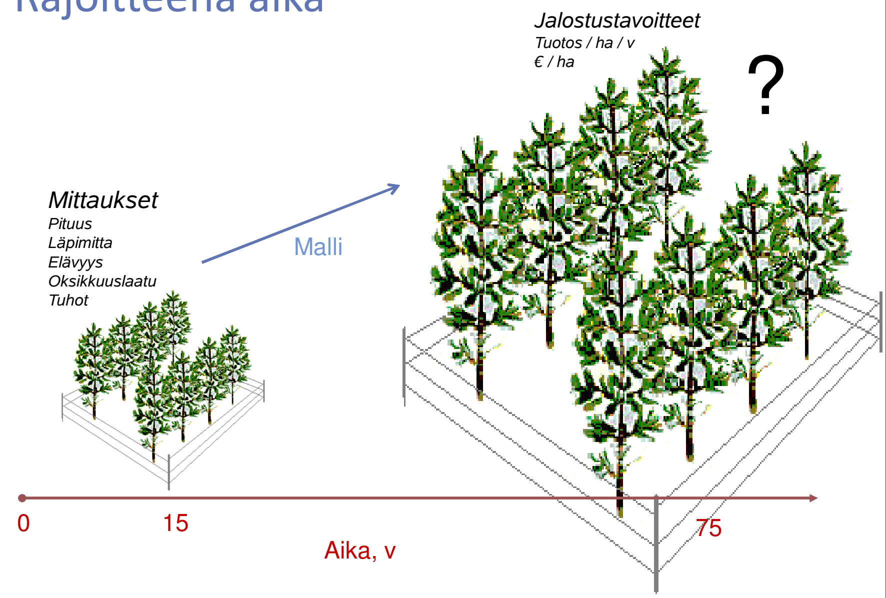
Rajoitteena aika



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Jalostushyödyn ennustaminen

1. **Geneettiset parametrit**
   - Jalostettavan ominaisuuden geneettinen varianssi
   - Valitun ominaisuuden periytyvyysaste
   - Valitun ja jalostettavan ominaisuuden geneettinen korrelaatio
   - Valinnan intensiteetti
   - Parametrit estimoitava kenttäkokeista

2. **Kasvumallit**
   - Nuorella iällä mitatun jalostushyödyn sisällyttäminen kasvumalliin ns. geneettisenä kertoimena
   - Metsikön kehitys simulointi kiertoajan loppuun

- Molemmilla tavoilla saatu samanlaisia arvioita

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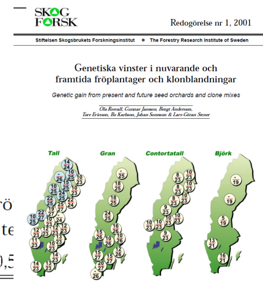

Vinstberäkningar för tall, gran och contortatall

Den **genetiska urvalsresponsen i arealproduktion** över en omloppstid, R_m uttryckt i procent, är uppskattad för dels additiva effekter (R_{Am}) när massförökning sker via frö och dels för genotypiska effekter (R_{Gm}) som realiseras vid vegetativ massförökning av kloner.

$$R_{A_m} = i\, r_{AI}\, r_{jm}\, \mathrm{CV}_{A_m} \qquad [1]$$

där CV_{Am} är additiva variationskoefficienten, d.v.s. additiva (A) standardavvikelsen i relation till medeltalet för den slutliga målvariabeln (m) som avser arealproduktion över hela omloppstiden och över hela användningsområdet, d.v.s. inkluderar genotyp $\times$ miljösamspel $(G \times E)$; r_{AI} är korrelationen mellan ett index för mätt (I) och sant värde (A) för mätvariabeln vid ung ålder, som är t.ex.

Vid avkommeprö... till en fröplantage blir te...

$$r_{AI} = \frac{0,5 \ldots}{\sqrt{0,25\sigma_A^2 + \frac{(0,75 \ldots)}{m}}} \qquad [3]$$

Vid urval till en fröplantage i kontrollerade korsningar (här en korsning per förälder) blir testsäkerheten för urvalet mellan familjer:

$$r_{AImf} = \frac{0,5\sigma_A(1+1/m)}{\sqrt{0,5\sigma_A^2 + 0,25\sigma_D^2 + \frac{(0,5\sigma_A^2 + 0,75\sigma_D^2 + \sigma_E^2/n)}{m}}} \qquad [4a]$$

och för urvalet inom familjer till en fröplantage:

$$r_{AIif} = \frac{0,5\sigma_A(1-1/m)}{\sqrt{(0,5\sigma_A^2 + 0,75\sigma_D^2)(1-1/m) + \sigma_E^2/n}} \qquad [4b]$$

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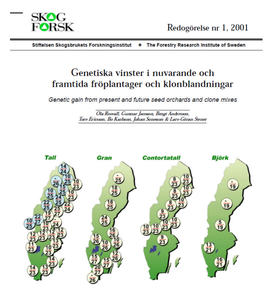

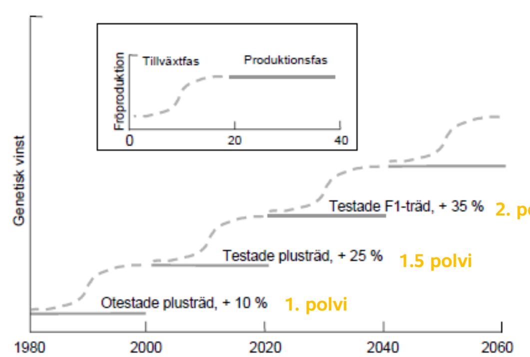

Figur 3.
Under tiden en fröplantage producerar frö befinner sig efterföljande plantage i tillväxt. Här illustreras det med ett 20-årigt omdrev.

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Tuore review-artikkeli jalostushyödyistä Pohjoismaissa (2016)

SCANDINAVIAN JOURNAL OF FOREST RESEARCH, 2016
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The genetic and economic gains from forest tree breeding programmes in Scandinavia and Finland

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ABSTRACT
Plantations of genetically improved forest trees are critical for economic sustainability in forestry. This review summarizes gains in objective traits and the resulting economic impact of tree breeding programmes in Scandinavia and Finland. Genetic improvement of forest trees in these countries began in the late 1940s, when the first phenotypically superior plus-trees were selected from natural environments. The main findings from this review are that (i) tree breeding can increase volume growth in the range 10–25%, and (ii) the bare land value associated with genetically improved trees gives a better return on investment and a shorter rotation period compared to the unimproved forests. As some Nordic countries are quite dependent on the forest industry, breeding programmes that have resulted in economic gains have been beneficial for society. Growth and wood quality traits are often adversely correlated, and the weighting of traits from an economic perspective could provide an index for determining maximum profit from breeding. Tree breeding faces an array of challenges in the future, such as changes in silviculture, climate, new pests and diseases, and demand for wood-based products.

ARTICLE HISTORY
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KEYWORDS
Genetic improvement; economic benefit; genetic gain; economic gain; productivity; tree breeding; seed orchard

Table 1. Summary of estimates of genetic gains for various growth traits. Further details are described in the text.

Species	Trait	Genetic gain vs. unimproved (%)	Gains refer to	Reference
Scots pine	Volume per unit area through rotation based on genetic parameters	10	First round of seed orchards (Sweden)	Rosvall et al. (2001)
	Volume per unit area through rotation based on genetic parameters	25	Third round of seed orchards (Sweden)	Rosvall et al. (2001)
	Volume per unit area through age 30	12	Control-pollinated progenies of phenotypically selected plus-trees (southern Sweden)	Jansson (2007)
	Volume per unit area through age 30	25	Control-pollinated progenies of the best 25% plus-trees (southern Sweden)	Jansson (2007)
	Volume per unit area through rotation	8.3–10.7	Control-pollinated progenies of phenotypically selected plus-trees (northern Sweden)	Andersson et al. (2007)
	Stem volume growth (age 27)	18.9	Control-pollinated progenies of phenotypically selected plus-trees, northern Sweden	Andersson et al. (2007)
	Mean annual yield per area through rotation	11.5	First-generation seed orchard seedlots (Finland)	Haapanen et al. (2016)
	Mean annual yield per area through rotation	23.9	1.5-generation seed orchard seedlots (Finland)	Haapanen et al. (2016)
Norway spruce	Volume per unit area through rotation based on genetic parameters	10	First round of seed orchards (Sweden)	Rosvall et al. (2001)
	Volume per unit area through rotation based on genetic parameters	25	Third round of seed orchards (Sweden)	Rosvall et al. (2001)
	Stem volume growth (age 29)	10–25	First-generation seed orchard seedlots (Norway)	Kvaalen et al. (2008)
Birch	Volume per unit area through rotation based on genetic parameters	5–20	Seed orchards with phenotypically selected plus-trees and tested plus-trees, respectively (Sweden)	Rosvall et al. (2001)
	Stem volume growth (age 8–12 years)	26–29	Seed orchard progenies of second-generation phenotypically selected plus-trees (Finland)	Hagqvist and Hahl (1998)

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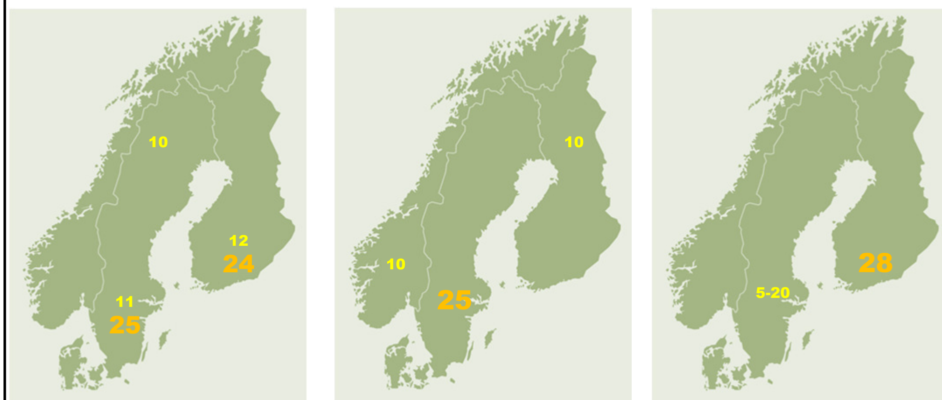
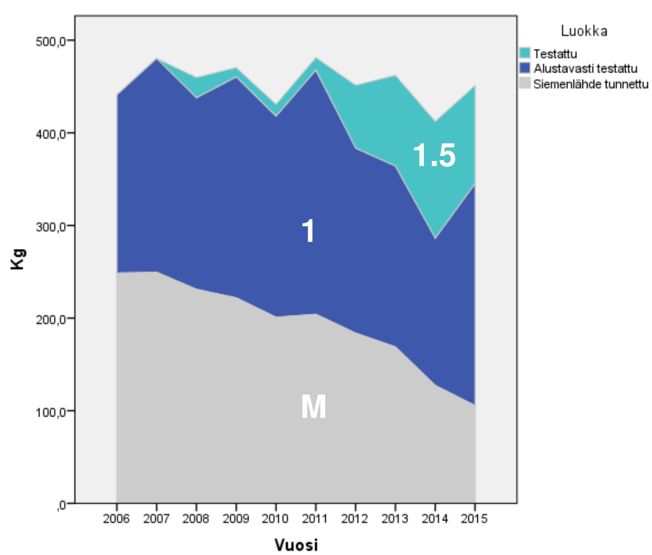
Jalostushyödyt Pohjoismaissa



Mänty **Kuusi** **Rauduskoivu**

Kiertoajan puuntuotos +10…+25 %

Männyn taimitarhakylvöt Suomessa



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Ensimmäinen empiirinen tutkimus 1.5 polven siemenviljelyssiemenen jalostushyödyistä

Eur J Forest Res
DOI 10.1007/s10342-016-0989-0

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ORIGINAL PAPER

Realised and projected gains in growth, quality and simulated yield of genetically improved Scots pine in southern Finland

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Received: 1 June 2016 / Revised: 12 August 2016 / Accepted: 16 August 2016

Abstract Scots pine (*Pinus sylvestris*) seedlots of different genetic quality were compared in realised gain trials at six sites in southern Finland at an age of 14–15 years. Synthetic seedlot mixtures of 1.5-generation plus trees showed consistent superiority to both first-generation orchard seedlots and unimproved checklots in growth, slenderness and relative branch size. Open-pollinated offspring from first-generation orchards, in turn, outperformed unimproved trees in most growth and quality traits. The mean incidence of ramicorns and forks was similar between unimproved and first-generation orchard trees, but slightly elevated in the 1.5-generation stock. Stand-level yields were projected for two virtual sites in southern Finland using simulation software MOTTI. The development of improved stands was modelled by incorporating genetic gains in height and diameter growth in the asymptote parameter of the Chapman–Richards growth function. The mean annual yields of the first-generation and 1.5-generation orchard stock were, as an average over the two sites, 11.5 and 23.9 % above the unimproved stock, respectively. For juvenile, fully contaminated 1.5-generation orchards, the genetic gain was 15.9 %. The predicted reduction in the length of commercial rotation due to genetic improvement varied between 4 and 17 years depending on the site, orchard generation, level of pollen contamination and genetic thinning. The results indicated substantial returns on investments on improved reforestation stock in southern Finland. Increments in bare land value (using a 3 % interest rate) ranged from 529 to 1836 € ha^{-1} (30.5–60.5 % above unimproved stock).

Keywords Genetic gain · Seed orchards · Forest tree breeding · Genetic multipliers · Bare land value

Introduction

Seed orchards are the most widely used delivery system to transfer gains from tree breeding programmes to forestry (Sweet 1995; White et al. 2007). In Europe alone, there are over one thousand seed orchards occupying a land area of nearly 7000 ha (Paques 2013). A large majority of them have been established with vegetative propagules of plus trees selected in wild stands for their outstanding phenotype. Reflecting the progress made in tree breeding, the next round of seed orchards usually includes only a subset of the plus trees which have been shown by progeny testing

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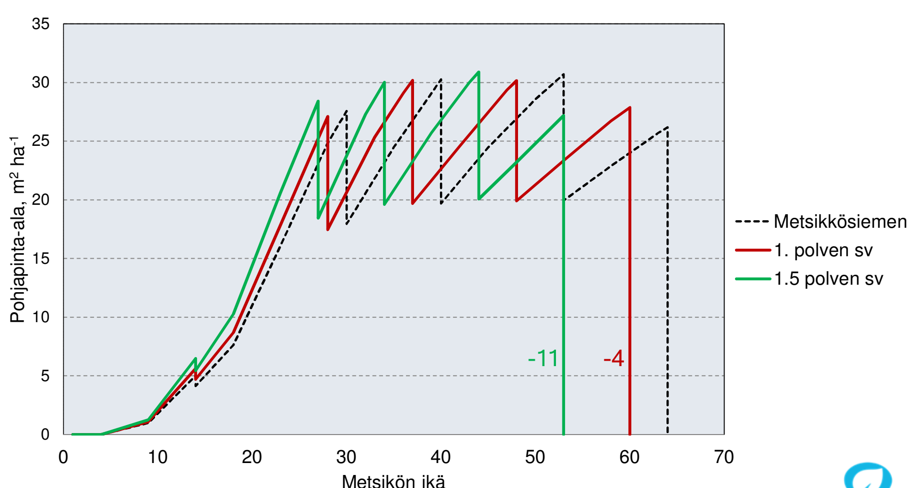
MOTTI-simulointi: männikön uudistaminen istuttamalla, tuore kangas, 1200 d.d.



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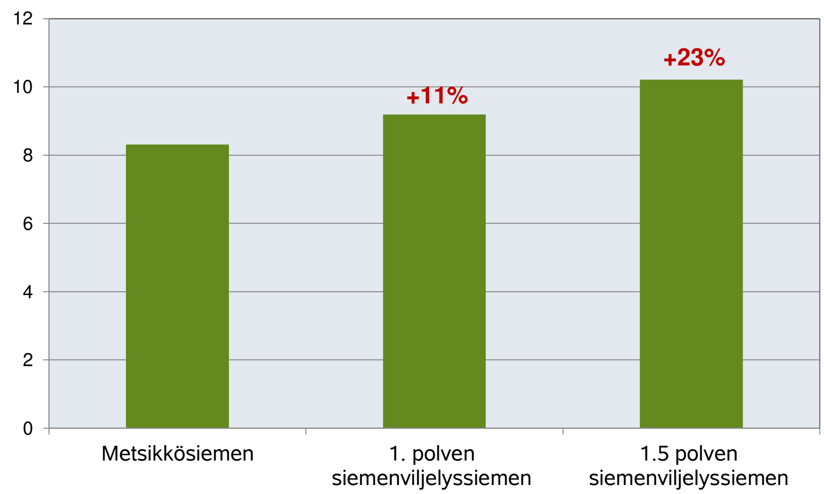
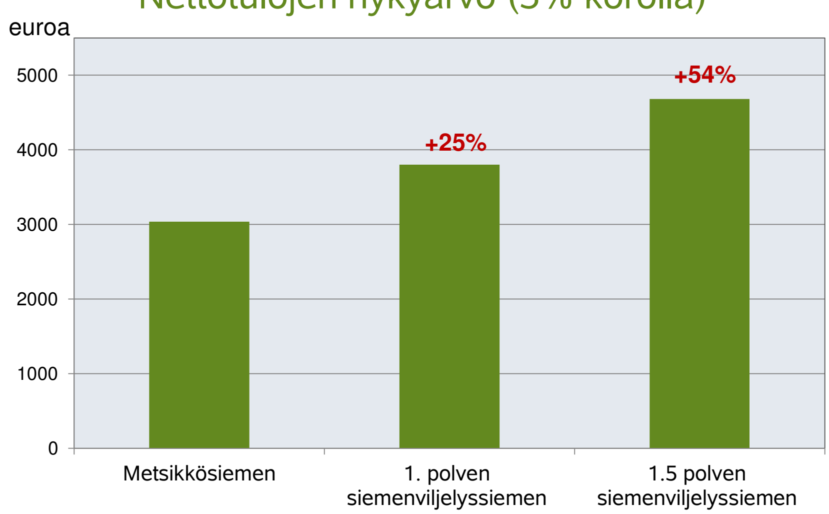
Männikön keskituotos, m^3/ha/vuosi



Nettotulojen nykyarvo (3% korolla)



Tutkimuksen päätulokset

- 1. polven siemenviljelykset: n. **12-13%** keskituotoksen lisäys
- 1.5-polven varttuneet siemenviljelykset: n. **24%**
- 1.5-polven nuoret siemenviljelykset: n. **15%**
- Kiertoajan lyheneminen skenaariosta riippuen **4…8** vuotta (1. polven sv-siemen), **8…17** vuotta (1.5 polven siemen)
- Taloudellinen tuloksen hyödyt (paljaan maan arvo) tuplasti korkeammat
- Arviot taloudellisista parannuksista lähtökohtaisesti **aliarvioita**
  - Laadussa saatujen parannusten mallintamiseen ei ole vielä hyviä työkaluja

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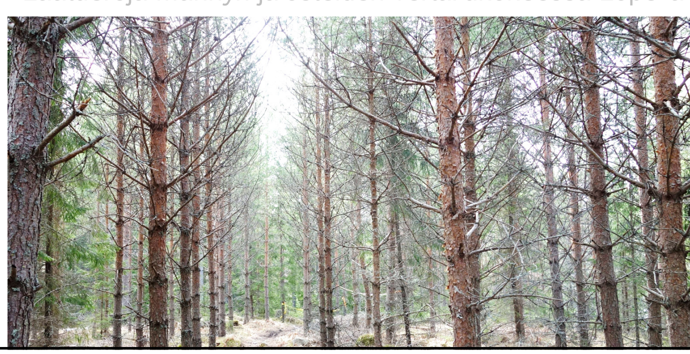
Pluspuiden jälkeläiset

Laatueroja männyn jalosteiden vertailukokeessa Lopella



Metsikkö-siemen

Näyttö jalostushyödyistä

- **Kaikki** tutkimukset metsäpuilla Pohjoismaissa ja muualla maailmassa todistavat johdonmukaisesti ja **poikkeuksetta** jalostushyödyistä
- Täysin odotettu tulos
- Perinnöllisyyden säännönmukaisuudet ja valintajalostuksen mahdollisuudet ovat metsäpuilla aivan samat kuin muillakin kasveilla ja eläimillä
- Muunlaista tulosta olisi hyvin vaikea selittää!

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